Log.

Comp. to 180°=a=59° 59' 59".62 cof. .5000015.9=.6989714

$-x=$ .0167923.

.4832092.9=.6841352

diff. = .0148362

Cotang. 59° 59' 59".52 = 9.7614412

9.7466050

+ 613

Tang. 29° 9' 48" = 9.7466663

+ 90

True anomaly 119° 9' 48"

Mean anom. 120 50 00

Equation — 1° 40' 12"

If the 1ſt and 6th 60° of mean anomaly in the Earth's orbit be computed by the firſt ſeries, the 3d and 4th 60° by the ſecond ſeries, and the 2d and 5th by the laſt ſeries, no more than the firſt 3 terms containing powers of z, need be uſed, for the equation cannot be had true to $\frac{1}{100}$ of a ſecond without tables of logarithms carried farther than to 7 places.

N°. IV.

On the Improvement of Time-keepers, by DAVID RITTENHOUSE, L. L. D. *Preſident of the Society.*

Read Nov. 7, 1794. THE invention and conſtruction of time-keepers may be reckoned amongſt the moſt ſucceſsful exertions of human genius. Pendulum clocks eſpecially, have been made to meaſure time with aſtoniſhing accuracy; and if there are ſtill ſome cauſes of inequality in their motions, the united efforts of mechaniſm, philoſophy and mathematics will probably in time remove them.

The laſt and leaſt of thoſe cauſes, which perhaps may be worthy of notice when all others of more importance are

are removed, is that ariſing from the unequal denſity of the air, which by varying the actual weight of the pendulum will accelerate or retard its motion The effects ariſing from this cauſe will indeed be found very ſmall, for if we ſuppoſe the greateſt range of the barometer to be three inches, which indicates a change of denſity in the air of about one tenth of the whole; and ſuppoſing lead, of which pendulums are generally made, to be 8,800 times heavier than air, the variations of the actual weight of a pendulum may be one-88000th part of its whole weight, and conſequently the change in its rate of going one-1760000th part. And, as there are 86,400 ſeconds in a day, the clock may vary in its rate of going, from this cauſe, about $\frac{1}{2}$ a ſecond in 24 hours. Mentioning the barometer ſeems naturally to point out a remedy for this cauſe of irregularity by means of that inſtrument. But my deſign is at preſent to deſcribe a very different and extremely ſimple method, which though only a matter of curioſity at preſent, may at ſome future time perhaps be found uſeful; eſpecially as the variation above mentioned is governed ſolely by the actual denſity of the ſurrounding air, and the barometer can only give the weight of an intire column, which does not ſtrictly correſpond with the denſity of its baſe; whereas the method I propoſe depends on the real denſity of the air ſurrounding the pendulum, and nothing elſe.

Let AB (Plate I. Fig. 9.) be a pendulum vibrating on the point A, and removed from the perpendicular line DE. Let the inflexible rod be continued from BA to C, and let a body C, of equal dimenſions with the pendulum B, but hollow and light as poſſible, be fixed on the rod, making AC equal to AB. Now it is evident that B will be preſſed upwards by a force equal to the weight of its bulk in air, and its deſcent retarded. But the body C, will be equally preſſed upwards, and conſequently the motion of the pendulum

pendulum towards the perpendicular will be as much accelerated. Theſe two forces therefore will deſtroy each other, and the pendulum will perform its vibrations in equal times, whether the air be light or heavy, denſe or rare.

I have for greater perſpicuity deſcribed the moſt ſimple caſe, but perhaps not the moſt eligible, for if we can enlarge the veſſel or body C, in any proportion, the diſtance of its center from A may be diminiſhed at the ſame rate.

However plauſible the above may appear in theory, no doubt difficulties will occur when we attempt to reduce it into practice. But I am perſuaded they will not be found inſuperable.

The only experiment I have hitherto made on this ſubject has been merely to ſhew that a pendulum can be made in this manner which ſhall vibrate quicker in a denſe medium than in one more rare, contrary to what takes place with common pendulums.

I made a compound pendulum on the principles above mentioned, of about one foot in its whole length. This pendulum, on many trials, made in the air 57 vibrations in a minute. On immerſing the whole in water it made 59 vibrations in the ſame time, ſhewing evidently that its motion was quicker in ſo denſe a medium as water than in the air. When the lower bob or pendulum only was plunged in water it made no more than 44 vibrations in a minute. The remaining 15, being ſolely the effect of the preſſure of the water againſt the upper veſſel C.

On

Fig. 2. P. 54.

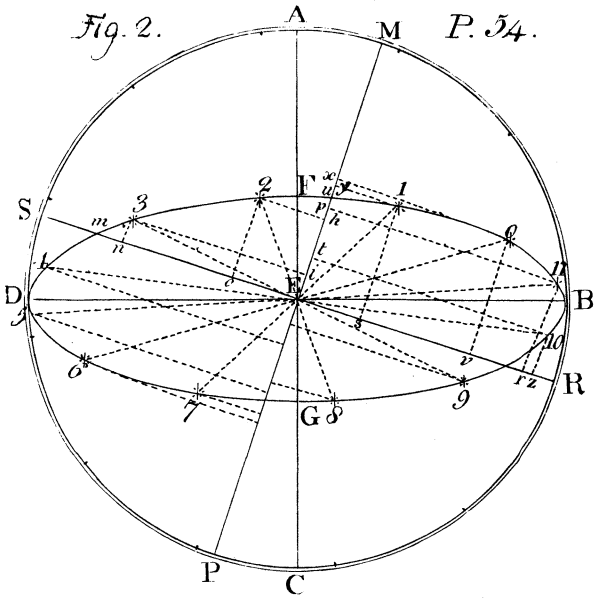

Fig. 1. P. 51.

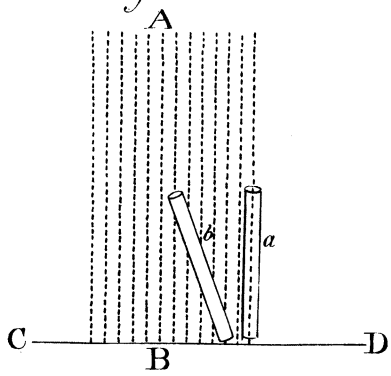

Fig. Θ P. 27.

Fig. 3. P. 58.

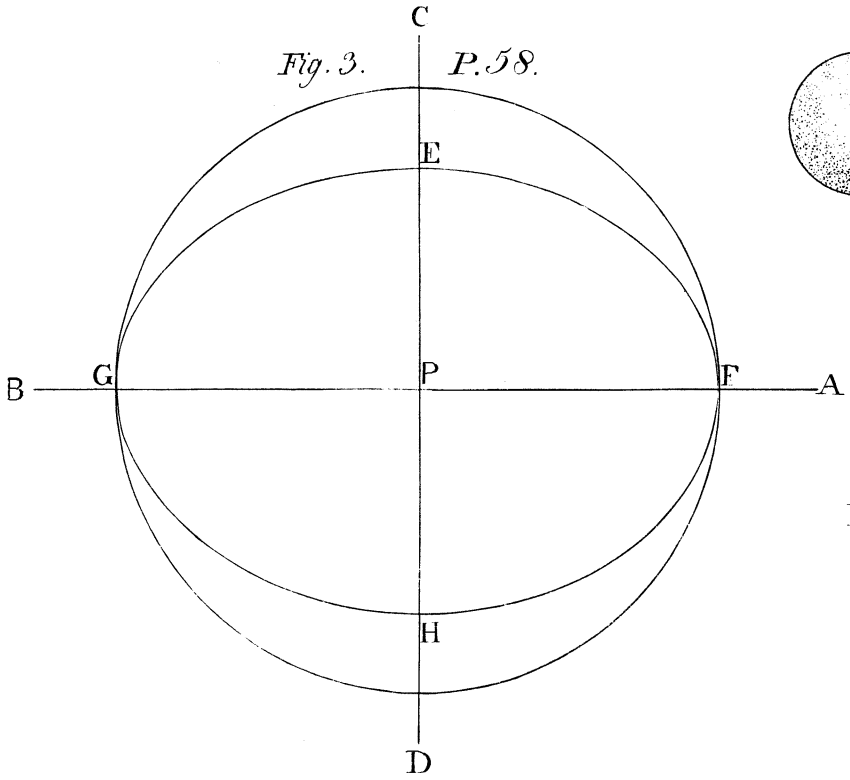

Fig. 1. P. 58.

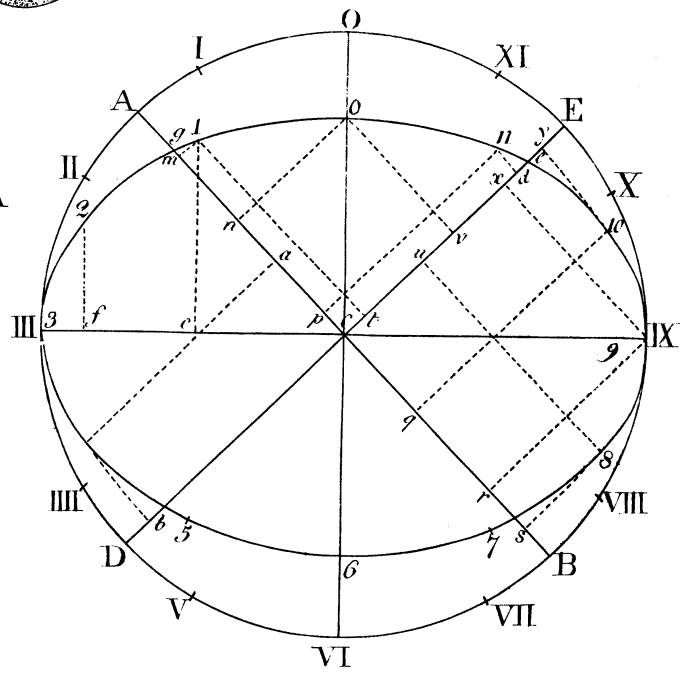

Fig. 5. P. 65.

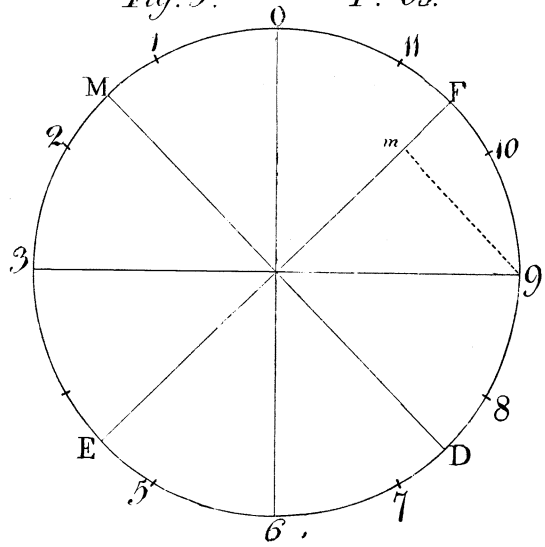

Fig. 9. P. 67.